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ON THE EVOLUTION OF THE ART OF WORKING IN STONE.

A Preliminary Paper.

BY J. D. MC GUIRE.

Heretofore the great stages of culture of man in Europe as well as in parts of Asia and Africa have been designated as those of stone, bronze, and iron, whereas in America and Oceanica man is supposed not to have progressed beyond the pure stone age. There is, however, evidence of some use of bronze in South America prior to the advent of the discoverers of the continent.

The stone age of the world has been almost universally supposed to have been divided into two distinct periods. the one an age in which man used only rude chipped implements, and the other an age in which man chiefly used polished implements.

The paleolithic period has been asserted to have continued from man's first use of stone as a weapon or tool—supposed to be somewhere in a geologic age earlier than that in which we live—on through a vast and indeterminate time when only stones that were rudely chipped were employed, to that comparatively modern period when it is supposed man first learned the rat of polishing his implements. The evidences of this first period of man's development as an intellectual creature are said to be discoverable only in the gravel beds, in the loess or in the lower strata of caves, associated with the bones of a fauna now nearly or entirely extinct.

The neolithic period, on the other hand, is asserted to be that age where man had advanced to a knowledge of the art of polishing his implements as distinguished from the art of chipping them, which has generally been considered as a clear evidence of wonderful improvement. As might naturally be expected, great difficulty has arisen in distinguishing articles from a given locality as belonging to the one or other of these ages. From the great similarity existing between a number of "finds" heretofore made in America, and European specimens from analogous strata, the same conditions are supposed to have existed in America as are believed to have occurred in Europe. There is no good reason why evidences of man's ancient existence should not be found in America as elsewhere. Taking the type of the implement as a criterion of antiquity, America, Europe and Asia stand on the same footing. It is proposed to discuss the data for a belief in the existence of distinctive paleolithic man in Europe and America without reference to the other great geographical subdivisions.

Doubt has recently been expressed as to the value of American gravel finds as establishing an era of "chipped" stone on this continent. The "paleoliths" of the Trenton gravel found on or near the Delaware river, as well as those found at the Little Falls on the Mississippi, are claimed by Professor W. H. Holmes, whose views are sustained by many well-known geologists, to belong to the talus of the rivers' banks, or, if found on the plateaus above, to be so near the surface as not to be necessarily of great age, and are shown to be similar in every particular to rejected material found in aboriginal quarries worked by American Indians in comparatively recent times.

Dr. Abbott, Professor Wright, Professor Haynes, and others combat the views of Professor Holmes. Discoveries in the gravels and caves of Europe of stone implements associated with the bones of extinct animals have been so often recorded, and by men of such probity and recognized ability as to place the fact of their occurrence beyond contradiction, so far at least as that country is concerned. The contents of American gravels are so little known that it may be argued that there are not at present sufficient data upon which to predicate an intelligent opinion as to the contemporaneity of man with extinct animals upon this continent. The contents of American caves are as yet unknown, none, so far as the writer is informed, ever having been thoroughly examined, so that no assertions as to what they may develop can amount to more than surmise.

The similarity of much of the American quarry refuse with the European paleoliths is very striking. The character and size of the chips detached appear identical, as do the so-called implements, when laid one beside the other. It is claimed by the writer that, judging this question from a purely archeological standpoint, the paleoliths of Europe and the similar American implements are in all particulars identical and are the productions of man existing under like conditions.

The writer expects to show that among the best-known authors on European archeology there is no unanimity of opinion as to the status of the chipped stone age, and it will be further argued that, all things considered, the weight of authority is against the existence of any considerable period of time in which man lived, either in Europe or America, when his only implements were those which were chipped. This opinion is advanced with all due deference to the views of the large class who differ from it and without in any sense calling in question the great value of the opinion of geologists, prehistoric archeologists, anatomists, and those who believe in the evolution of man from the lower orders of the animal kingdom.

The theories here advanced as being worthy of some consideration in forming an opinion on the probable development of stone implements are based chiefly on a series of experiments made during the last two years to ascertain the aboriginal methods of working stone. These experiments seem to demonstrate satisfactorily how man fashioned his implements and to give a basis upon which to form an opinion that is of value. In fact, it is believed that by means of these experiments some of the aboriginal methods employed in fashioning tools of stone have finally been ascertained.

The writer has for more than twenty years been collecting stone implements, and has also some knowledge of what has been written on the subject in both Europe and America, and has not been unmindful that there are many data contained in the works written by travelers among races living under primitive conditions that throw light upon archeological matters. The accuracy of the theory of chipped and polished stone ages was for many years accepted by him without question because of the supposed unanimity of opinion on the subject expressed among archeologists. An active experience of two years' almost constant work in an endeavor to reproduce aboriginal methods of work, chiefly in stone, with tools of stone, wood, and bone, such as are found in the village sites in America and Europe, as well as with tools found in graves and those used by races living in low stages of savagery, and also with methods of work described by travelers in America and elsewhere, has, however, had a tendency to raise doubts where formerly there were none, and to simplify much that had appeared difficult. These doubts have in many instances resulted in conviction that much that has heretofore been accepted as being beyond question in regard to stone implements has been based on erroneous data and is open to serious criticism.

An examination of any local collection of artificial stone of any period will, it is thought, convince the investigator, if he be well acquainted with the minerals of the locality in which the collection was made, that those who fashioned these implements not only knew the stones of the particular vicinity, but that they were acquainted with their fracture and adaptability to a given purpose, whether that purpose was to grind, batter or *chip them into shape.* Almost any mineral may be ground, many can readily be battered but cannot be chipped; others may be readily chipped, but are destroyed in the attempt to batter them into form. On examination it is found that every rock has been worked in the best and most economical method which its texture admits.

A careful examination of any stone tool will readily show the method pursued in fashioning it, and it will be found that it was ground, battered or chipped, or that there was a combination of these processes for the same implement. The striæ produced by grinding often indicate the method of work. The composition of the stone, if ground, will often be of value in demonstrating whether battering or chipping preceded grinding. In chipped implements the size of the spalls will often show whether percussion or flaking was used, and upon occasion a magnifying glass will be found of great value in demonstrating minutiæ of work not readily distinguishable by the unaided eye.

Every day's work performed by the writer in working stone has added to the conviction that a person capable of chipping out a paleolith would, after at most a year or two spent in such manipulation, have acquired the skill requisite to batter an implement into shape, and subsequently, if necessary, to grind a blade to it in order to make it more serviceable and symmetrical. This view, if correct, would do away with the alleged differences in the paleolithic and neolithic periods, the terms first applied by Sir John Lubbock to distinguish the earlier from the later stone age. On the contrary, however, one might be an expert in grinding and battering stone, the simplest of processes, without ever recognizing or appreciating the value of chipping stone into form, which is one of the most difficult of methods known, and requires more skill, and a more intimate knowledge of the cleavage and fracture of minerals than any known to or practiced by savage man. And from the known methods pursued in producing chipped or battered and polished implements, the writer is convinced that the art of chipping, being so much more difficult than battering and grinding, is a later acquirement.

Does there appear any great difference in the characteristic work of battering, grinding, and chipping when regarded merely from a mechanical standpoint? Can one be in great doubt as to which process required the greatest amount of intellectual thought? Any one familiar with river pebbles will recall that outline forms of the so-called celt are generally present in the gravels of rivers or streams having a rapid fall; forms which are due to abrasion. These celt-like forms only require slight grinding at their broader ends to make superior implements. The river becomes a teacher whose lesson, the writer is forced to think, would be quickly learned even by a savage.

Battering one stone with another is among the first arts that man, even in the lowest stages of savagery, would be likely to discover, for if he ate nuts or cracked bones or crushed roots he would of necessity perform the work by means of placing the object on one stone and crushing it with another, and in most stones the operation of obtaining nuts sufficient for a meal would of necessity wear a cavity which would increase in proportion to its use, and such a lesson would not fail to be learned and profited by when necessity arose to fashion any desired form of implement. Chipping, on the contrary, is one of the most difficult of labors to perform with success. Even in comparatively modern times we learn that the art of chipping gun-flints was confined almost entirely to English artisans, and although suitable material for such flints abounds throughout Europe, the governments of the Continent at one time sent workmen to England to learn the art. Quartz and quartzite are even more difficult to chip than flint, for the stone is more refractory, and a careless blow given at an improper angle is sure to destroy the object intended to be fashioned. It is reasonable to suppose, when the different methods are understood, that man first learned the simpler art and later the more complicated, and it seems hard to believe that he lived for many centuries in ignorance of the simpler one that nature was performing daily in every stream under his eye and which he was himself performing constantly for other purposes, but learned one more complex and unfamiliar. Experience, as well as *a priori* reasoning, teaches that the art of grinding and battering stone must have preceded that of chipping.

Arrow-points and spear-heads may be made, as shown in Fig. 1, by setting the stone from which it is intended to fashion the implement on another stone and beating the edge of the implement with a stone hammer, by which method a fairly good blade may be produced. Professor Holmes has shown that the boulders in the Piney Branch workshop may be chipped by freehand percussion. There are, however, on this site boulders too large to work by any such process, many of them weighing fifty pounds or more. The writer, in an experience of several days at this place, found it impossible by the Holmes method to break many of the large stones lying on the surface, and even with the smaller pebbles found freehand percussion an unsatisfactory way of splitting them. The jar to the muscles of both arms is so severe in chipping whole pebbles as to persuade one against the theory that such a method was adopted by the Indians. An examination of those pebbles from which only two or three spalls have been detached convinces the writer that the first process at Piney Branch was to split the pebble open by hammering it between two stones, using a hand hammer for small boulders, and a small hammer with a flexible handle to detach spalls from the larger ones. The stone, being broken in a suitable man-

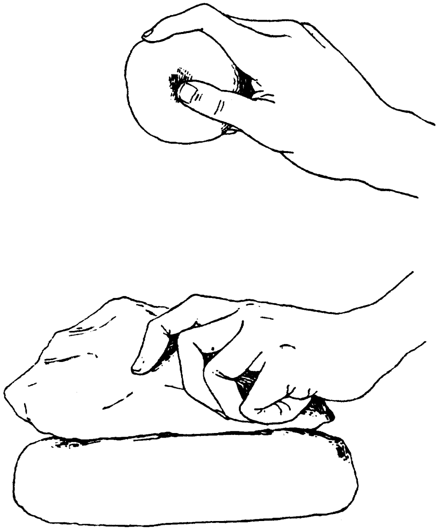

FIG. 1.

ner, was dressed down by a combination of the method shown in Fig. 1 and that suggested by Holmes, but the two combined explain the process to a certain extent only, for neither of these methods produces the perfect leaf-shaped implement. Were the objects in the Piney Branch workshop the production of "turtle-backs," why is it that we find so many thousands of stones yet lying on the surface of the hill, which a dozen blows would make perfect implements? On the other hand, we find in the same place but little material left from which flakes of sufficient size may be obtained from which to produce good blades, although there is abundant evidence that much of such material has been removed. The pebble being split open as indicated, one of the best methods then to pursue is to chip the stone into its desired outline with a deer-horn hammer, such as is still used by the natives of parts of Alaska. (Fig. 2.) This implement, for such a purpose, is easily held in the hand, and produces most satisfactory results with but slight exertion of force. To complete such an implement, however, the notched bone, punch, and flaking-tool were one or all used.

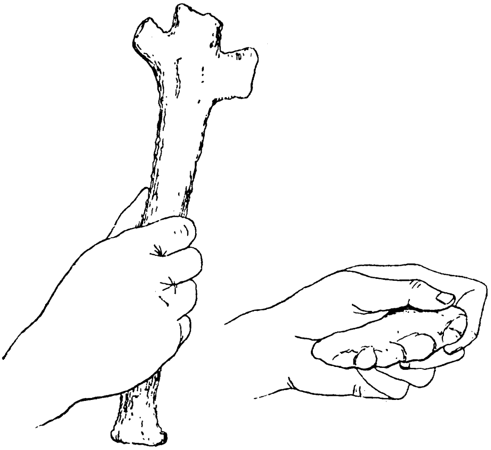

FIG. 2.

By whatever method the chipping was done, it must be admitted that it is one of the most difficult arts known to man.

According to Sir John Lubbock, the fauna of the paleolithic age comprised the mammoth, woolly rhinoceros, urus, cave-bear, musk-ox, etc., and man in that period is asserted to have been ignorant of the use of pottery and metal. The same distinguished author also asserts that out of 30,000 worked flints of Claleux and Furfooz not one presented a trace of polish, yet Southall asserts that pottery was found at Nibrigas, associated with a skull of the cave-bear, and at Engis cave, in Belgium, associated with the bones of the rhinoceros. According to Joly, M. de Bize found at Bize, in Aude, and M. de Christol, at Sauvignargues, in Gardes, fragments of pottery that it is scarcely possible not to consider contemporaneous with the reindeer and perhaps with the cave-bear, with whose remains they were found. Joly found pottery in a bear cave at Nabrigas, in Lozère, and M. Ferry at Vergisson, near Maçon. M. Dupont, in Belgium, found rude pottery associated with the bones of the mammoth and rhinoceros in the Trou Magrite, and says: "All the dwelling places of our indigenous ancestors contained fragments of very rough pottery."

MM. de Puydt and Lohest found in the grotto of La Biche aux Roches near Spy, in the province of Namur, a cavern which showed no evidence of having ever been disturbed. The first layer, 1.^{m}60, of broken-down argillite produced a recent skull. The second layer, 0.^{m}80, a tufa of bones, produced *Elephas primigenius*, *Cervus canadensis* (?), and flint chipped generally on one side, of the Mousterian type. The third layer, 0.^{m}30 in thickness, produced *Rhinoceros tichorhinus*, *Cervus elaphus*, the teeth of a large species of *Felidæ*, and bones that are supposed to belong to *Elephas antiquus*, Mousterian implements; a bone baton of command, a hollow bone containing oligiste (ochre?) powdered, several little ivory plates of mammoth tusk representing seals, resembling a worked stone from a mound in Vermont, and three fragments of burned pottery. The fourth layer, 0.^{m}40, produced two human skeletons, three Mousterian points, bits of ivory and bones supposed to be similar to the layer above.

M. Albert Gaudry describes a baton of command beautifully carved with animals, with a large hole bored through it, found in the grotto of Montgaudier in the same layer with *Felis spelæus*, *Ursus spelæus* (*?*), *Rhinoceros tichorhinus*, and pieces of worked ivory of mammoth tusk. In almost all of these caves are found bone needles with bored eyes.

According to Schliemann, what he, Professors Lindenschmidt and Virchow, M. Burnouf, and Dr. Nicolucci call corn-bruisers, or ancient millstones, are found in the caves of the Dordogne. These so-called corn-bruisers, according to Lartet and Christy's book, "Reliquiæ Aquitanicæ," are what are known to American archeologists as pitted hand-hammers, and were found in the caves of Les Eyzies, La Madeleine, Gorge D'Enfer, and Laugerie Basse.

Lubbock and others place the Danish kitchen heaps in the Neolithic age, while Sophus Miller speaks of the chisels there found as belonging to the earliest period of man. Pottery is asserted to belong to the neolithic period, yet numerous authors have found it associated with an early cave fauna. Lartet found bored cockles and the tusk of a young ursus bored lengthwise in a cave near Aurignac, and Dr. Rigollot found fossils of the chalk with cavities bored in them in the gravel pits of St. Acheul. Similar instances have occurred in many localities of the finding of bored articles, pottery, and notably of pitted hand-hammers, associated with the bones of the mammalia of the drift. In Missouri it has been asserted by Dr. Koch that he found the bones of the mammoth associated with pottery, arrow and lance heads, axes, and ashes. All over the world we find early man to have lived in an identical manner, using similar tools, and struggling with the wild beasts for the possession of caves to shelter them from the inclemency of the weather. The absence of celts from the drift and of implements of the drift type from tumuli is used as an argument to sustain the different ages of stone, yet the American workshops present to us the true paleolithic type of implement, and from the hundreds of thousands of tons found within eight feet of the surface in one or another locality, it may be doubted whether a single polished implement could be found. The character of work performed upon such a site would make it improbable that polished implements would be likely to occur there, upon the same principle that the extensive steatite quarries found along the Atlantic seaboard (which were worked by the aborigines within the historic period) are, so far as the writer is aware, totally without pottery, arrow-points, or spear-heads. In large districts of Europe flint is everywhere abundant and of a cleavage suitable for the manufacture of most chipped tools, and as a consequence quarries would not be expected to occur. In America material suitable for chipping occurs only in isolated localities, and those places are found to abound in workshops. If the flint in Europe is of varying quality we may reasonably expect to locate similar sites even there.

One great argument in favor of paleolithic man in Europe is the absence of his implements from the tumuli. If the writer's views are correct the paleolith could in no sense be an article likely to be found in such places, where only completed implements would be deposited to serve the spirit in its journey to another world. The absence of unfinished implements from burial places is as marked in America as it is in Europe.

The average paleolith serves no purpose either as a fighting or as a working tool that could not be materially improved by one capable of fashioning the paleolith. It is argued that man was at so low a stage of culture as not to have sufficient intelligence to improve the shapes of implements, but that he imitated them through generations. Admitting the imitation, would not an improvement fashioned by accident be reproduced when found to be superior to the ruder tool?

It it not even possible that these sole evidences of paleolithic man have survived because they were the only ones fashioned from imperishable material?

Pottery could not exist in the drift, for although practically indestructible in a dry soil or climate, it lasts at most but a few months when exposed to water in motion. Not only would pottery be destroyed in this manner, but the bones of most animals would fare the same fate when exposed to the grinding and crushing of gravel in process of deposition. The gravel or small boulders of a river's bed are found to be composed almost entirely of quartzites and the harder stones, although the country through which the river flows may be composed largely of limestones and similar minerals. Owing greatly to the grinding process of the floods, the softer material becomes mud and sand, even the hardest being ground to small dimensions.

The opinions entertained by the classical Greek and Roman writers, that man in his first stage was but just removed from the brutes, accords singularly with the train of thought which the modern doctrine, according to Lyell, has developed; yet our knowledge of earliest implement-making man shows that he was a being endowed with intelligence by which he was from the outset enabled to crown himself their master, to employ their carcasses for food and their skins for clothing, and to fashion implements of stone, etc., by means of which he could maintain his supremacy over them for all time. That in the beginning his tools were rude and his existence precarious; that he had no fire; that he struggled with the bears and other wild beasts for the shelter afforded by caves to protect him from the inclemency of the weather, may be true; is there, however, substantial evidence that he lived through periods of time that can only be counted by many centuries, struggled with a fauna that became extinct before he had learned the art of grinding an edge to a stone, or working a rough block of mineral into a smooth one? That such a view can be successfully maintained must be doubted. The implements of the drift and of caves are, as a rule, of flint, a material that lends itself peculiarly to the chipping hammer, to bone hammers, to pressure, to grinding, and probably to other simple methods of detaching its flakes and thus giving it almost any desired form in the hands of even an amateur in chipping. But implements of flint, it may safely be said, are never found that have been battered into form; for this material, when struck a severe blow upon a flat surface by even a bone hammer, breaks across with a straight or nearly straight fracture. It is so compact in structure, and of such hardness, that specimens are rarely, if ever, found that have been bored.

In chipping something more is necessary than merely striking one stone against another. All chipped implements show a special fracture; the weight of the hammer, its material, and its shape are all important elements to be considered; the intended implement must be struck with a certain weight and force and at a particular angle to accomplish the desired result. The quarry hammer of great weight must be used if it is desired to crush a large block of stone; the hand hammer, to reduce it still further. Often possibly a set or punch and hammer or pressure alone may be used to accomplish the same purpose; then again a light bone hammer may be used to give uniformity to edges left rough by the hand hammer or to detach flakes from a brittle material. Again, in chipping, when a lump presents itself that cannot be readily detached, the intended implement would often be set edgewise on another stone, and by striking a vertical blow with a chipping hammer the lump would be detached, enabling the punch or flaking tool to complete the process without further trouble. As a finishing process, the bone flaking tool would be used. These various stages of the evolution of a block of stone into the completed tool may be recognized with some degree of accuracy, even among so-called paleoliths. The hand hammer used in chipping requires weight and hardness to facilitate the detaching of flakes, but any ordinarily hard stone that may be readily held in the hand wiil answer the purpose. In chipping stone the blow must be carefully calculated and its point of impact considered with a view to the chip which it is desired to detach, for a careless blow greatly endangers the safety of the implement. Whilst we cannot, with our present information, describe the precise method of fashioning a chipped implement from the time the original block of stone is attacked until the tool is finished, we can say with some degree of positiveness that the method is a complicated one.

That man may have existed for a great length of time without any implements is possible. Should we not, however, in arguing such a question, confine ourselves to available data without resorting to surmise? The most reasonable supposition in regard to the purpose of the many work-shops located in America appears to be, that they were the sources of supply from which the natives of a given locality obtained raw material to fashion subsequently into arrow and spear heads. In these localities they would lay in rudely shaped tools that were of a character that enabled them to remove the greatest amount of material with the least inconvenience. This supposition is sustained by the many finds of caches of lanceolate blades found all over America and even in Europe, attention to which was first called by Mr. W. H. Holmes.

The battering hammer is commonly a discoidal stone, having a rounded periphery, with a pit on each flat surface intended to hold the thumb and middle finger, whilst the index finger is placed on the periphery. The pits are but slight depressions, but are sufficient to prevent the stone from slipping as the blow is given, and at the same time enable the workman to raise the index finger slightly, and thus save the jar which would otherwise in a few minutes disable the arm. The blows with the battering hammer are given at the rate of two hundred or more a minute, which would be impossible with the ordinary chipping hammer. With this hammer rapidity is essential, and the blow is ordinarily given to a broad surface, and no deliberation is necessary. Battered objects are numerous and vary greatly in size; consequently the hammer is found to vary likewise. In America it is, as a rule, of quartzite, but not always so, being varied to some extent according to the material to be worked. If the implement to be fashioned was of indurated clay, any harder stone would be suitable as a hammer; if, however, a jadeite was to be fashioned, the hammer would be of like material, of jasper or some equally hard stone. Such hammers appear to be found all over the world and from the surface down to the lowest strata of the caves. They are common in the débris of the bottom city of Troy, fifty-two feet below the present surface, and are also found in the oldest lake dwellings and among the most ancient remains of all countries. It is probably more generally distributed than any other implement of which we have knowledge. How is this implement to be accounted for in the caves unless it were put to its natural use as a battering tool? That chipping can be done with it is true, but why make in an implement pits for which there is no need, and which if intended for chipping would really interfere with the work to be performed? The flattened sides, by reducing the weight of the hammer, would decrease the efficiency of the tool. Even the worn surface or periphery of these hammers, caused by being used to rub down the pecked surface, is often observable on specimens in America and Europe, and particularly at the site of Troy—in fact wherever the remains of man are found; and it is believed that this rubbed surface will be found wherever this class of tool is met with, whether in caves, shell heaps, lake dwellings, burials of all ages, or among the sculptures of America, Europe, Asia, or Africa. It was beyond doubt the great carving tool of antiquity, from the period when man first learned the art of carving stone on through the ages so long as hard stone was fashioned, and was only displaced by the discovery of the art of making steel.

We find, therefore, that there are evidences that man, as early as we have any knowledge of him, possessed the typical implement with which he could best batter and grind stone. He had knives with which he could cut various articles and needles with which to sew; he knew the art of making and burning pottery; could and did make fire; he drilled holes of large and small size in bones, antlers, shells, and fossils, and was familiar with the art of engraving at a period contemporaneous with the Mousterian implement and a quaternary fauna. With such evidences, can it be argued that man was ignorant of a knowledge of the process by which stone was battered and ground into shape and yet familiar with the more difficult and complicated art of chipping?

The writer has by experiment demonstrated the simplicity of the methods by which neolithic implements were fashioned, and has shown that what was supposed to require years to complete was in reality but the work of a few hours. The references herein given could be greatly increased were it necessary, but it is considered that sufficient data from the best sources have been given to show the error of the paleolithic hypothesis.

CRANIAL DEFORMITIES IN TOULOUSE.—M. le Dr. J. Ambialet, Prosecteur à la Faculté de Médecine de Toulouse, furnishes to *L'Anthropologie* of Paris a study of the artificial cranial deformities in Toulouse, which Broca and Dr. Delisle have before made known. They are produced by the *serre-tête* and a *bandeau* applied to the head of the new-born, and often worn by the women during their entire lives or replaced by other coiffures, viz., the "*sarradisso* and *foulard*," (the former a kind of close-fitting hood, the latter a handkerchief, held in place by a bandeau), which, by their constriction, prevent the return of the cranium to the state normal to it before it was deformed by the *serre-tête*.

Two types of deformities are produced, a horizontal and an oblique, according as the line of application of the constrictors approaches the horizontal or the vertical plane; each of these types again presenting varieties, the horizontal may be exaggerated, or slightly exaggerated, and the oblique may be oval, ascending cylindrical, or bilobed cylindrical. The deformation interferes with the symmetrical development of the cranial arch.

The numerous measurements taken enable Dr. Ambialet to advance three conclusions·

First. That the Toulousian is brachycephalic and mesaticephalic.

Second. That in the young generation the brachycephalic type tends to replace the mesaticephalic.

Third. That dolichocephalic and mesaticephalic crania are often due to constriction.

The Toulousian cranial deformation tends to produce dolichocephaly; and of forty cases observed in the very aged and adult classes, thirty-five are extremely deformed. Of eighty-eight mesaticephalic cases, fifty-seven presented deformations varying in degree, and in eighty-three brachycephalic cases, only four bore traces of the bandeau. The mesaticephalic Toulousians examined had very marked bregmatic depressions. The mechanism of the compression and of the consecutive cranial compensation furnishes the explanation of these varieties of conformation found in the horizontal type and called the "exaggerated," and in the oblique type and called the "ascending cylindrical."

As to the crania of the "oval" variety, they are generally mesaticephalic; nevertheless, they may be brachycephalic.